Pulmonary Function Test

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Disclosures / Objectives

- Recognize indications for spirometry and complete PFTs
- Interpret spirometry in the setting of clinical history
- Learn how to administer spirometry testing
- Explain the indication for ordering and interpreting spirometry and complete PFTs
- Utilize spirometry and complete PFTs when making a diagnosis in clinical practice
- This pulmonary function session will combine a practical review of spirometry as well as complete pulmonary function testing and its application in multiple clinical settings

Pulmonary Anatomy and Physiology

- People breathe 6 liters per minute
- Trachea, main bronchi have cartilage in their walls to prevent collapse
- Smaller airways do not have cartilage and pressure causes them to expand and contract
- Gas exchange occurs through the alveolar-capillary membrane

Pulmonary Anatomy and Physiology

- The contraction of the inspiratory muscles (especially the diaphragm) cause the chest cavity to expand, creating negative pressure
- External intercostals are involved
- The scalene muscle and the sternomastoid muscle can be involved in respiratory distress

Pulmonary Anatomy and Physiology

- Expiration is a passive process due to recoil of the chest wall
- Internal intercostal and abdominal muscles can help with expiration
- Lungs have elastic recoil (refers to the lungs returning to their "non-inflated" state on their own)
- Compliance refers to the amount of pressure required to inflate or deflate

Pulmonary Physiology

- Perfusion – blood flow through the pulmonary vessels
- Diffusion – movement of gases across the alveolar membrane
- Ventilation – air exchange between alveolar spaces and atmosphere

Purpose of PFTs

- Determine if NORMAL vs. ABNORMAL
  - If abnormal: WHY?
- Obstructive
- Restrictive
- Pulmonary Vascular Disease
  - Pulmonary HTN
  - Chronic Thromboembolic Disorder

PFTs - Indications

- Baseline Lung Function
- Diagnosis of dyspnea
- Pre-operative evaluation/pre-procedure evaluation
- Monitoring of progression of pulmonary disease
- Periodic evaluation of workers exposed to harmful materials
- Worker's comp claims
- Monitoring after pharm. or surgical intervention
- Monitor therapy

Contraindications

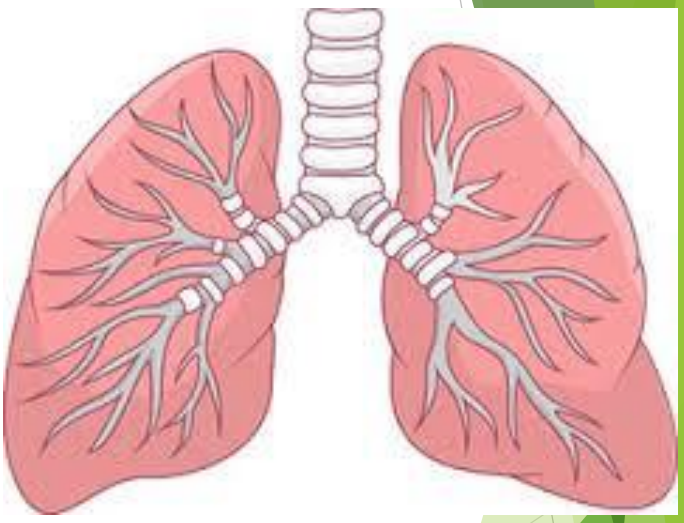
- There are no absolute contraindications, but consider your patient
  - Elderly
  - Weak
  - Too dyspneic
  - Patients with Dementia
- If tachycardic, avoid bronchodilator
- Hemoptysis / PTX

PFTs

- Quality of Test – ATS Standards
- Measurement of the Lungs
- What is normal?
  - Based on:
    - Height
    - Age
    - Gender
    - Race
  - Will give you PREDICTED VALUES

What do PFTs measure?

- Patency of airways (large and small)
- Parenchyma
  - Interstitial / alveoli
- Pulmonary Vasculature
- Diaphragm / Chest wall movement
- Neural control of ventilation
  - Ie: the brain



Milkshake/ Straw

- Size / Volume of shake = volume of lungs
  - Smaller size = restriction
- Straw = airway
  - How fast you can drink the milkshake
  - Tiny straw = obstruction
- Normal Range for PFTs
  - 80-120%

Obstructive Pattern

- Thin straw
  - COPD (chronic bronchitis / emphysema)
  - Asthma
  - Bronchiectasis
  - Cystic Fibrosis
  - Bronchiolitis

Obstructive Disease / Defects

- Peripheral airway disease // Smaller airway
  - Bronchitis, bronchiectasis, CF, asthma
- Pulmonary parenchymal disease
  - Emphysema
- Upper airway disease
  - Tumors, edema, infections, foreign body, collapsed airway, stenosis

Restrictive Pattern with Bear Hugs

- Belt around the lungs
  - Scoliosis / kyphosis
  - Phrenic nerve paralysis
  - Fibrosis
  - Obesity
  - ALS
  - Pulmonary edema
  - Extrinsic vs intrinsic causes

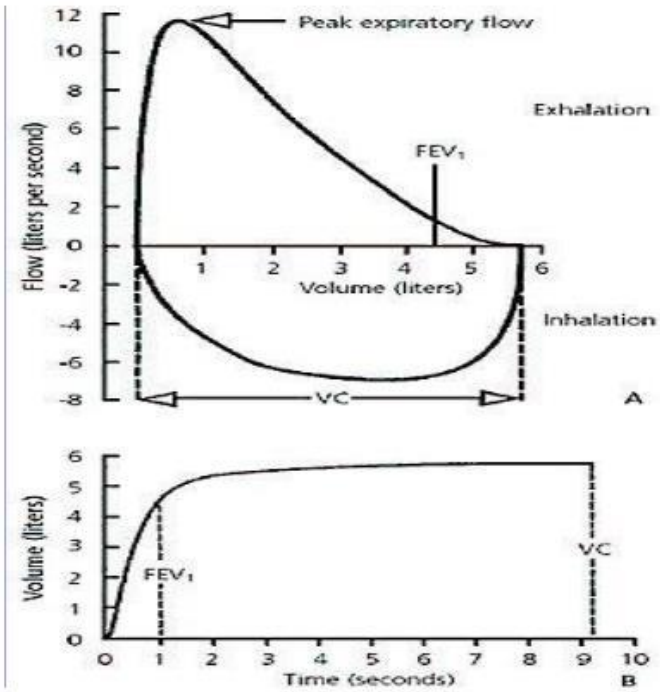
Restrictive Defects

- Intrinsic
  - Sarcoidosis
  - Tuberculosis
  - Pneumonia
  - Pneumonectomy
  - Interstitial Lung Disease
    - Pneumonitis, fibrosis, pneumoconioses, granulomatosis, edema, sarcoidosis
- Extrinsic
  - Scoliosis
  - Ankylosing Spondylitis
  - Pleural effusions
  - Pregnancy
  - Obesity
  - Pleurisy
  - Tumor
  - Ascites
  - Chest Wall Disease
    - Injury (rib fracture), kyphoscoliosis, neuromuscular disease

Neuromuscular Restrictive Lung Disease

- Malnutrition
- Paralyzed Diaphragm
- Muscular Dystrophy
- ALS
- Myasthenia Gravis

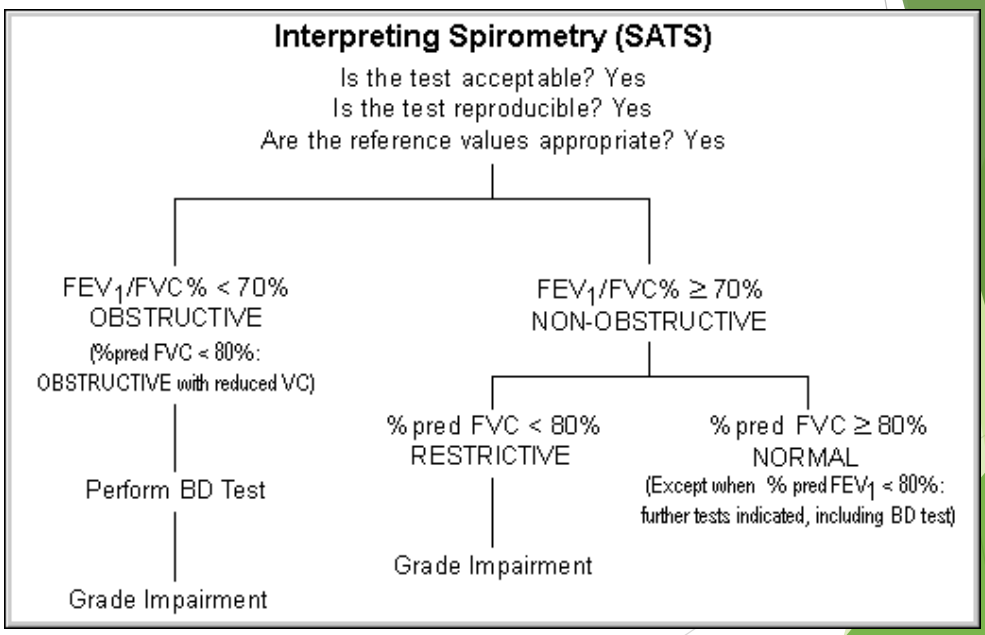
Flow Volume Loop



PFTs

- Spirometry
  - FVC
  - FEV1
  - Ratio
- Lung Volumes
- Diffusion Capacity

Spirometry


Interpreting Spirometry (SATS)
Is the test acceptable? Yes
Is the test reproducible? Yes
Are the reference values appropriate? Yes
FEV1/FVC% < 70%
OBSTRUCTIVE
(%pred FVC < 80%:
OBSTRUCTIVE with reduced VC)
Perform BD Test
Grade Impairment
FEV1/FVC% ≥ 70%
NON-OBSTRUCTIVE
% pred FVC < 80%
RESTRICTIVE
Grade Impairment
% pred FVC ≥ 80%
NORMAL
(Except when % pred FEV1 < 80%:
further tests indicated, including BD test)

FVC (Forced Vital Capacity)

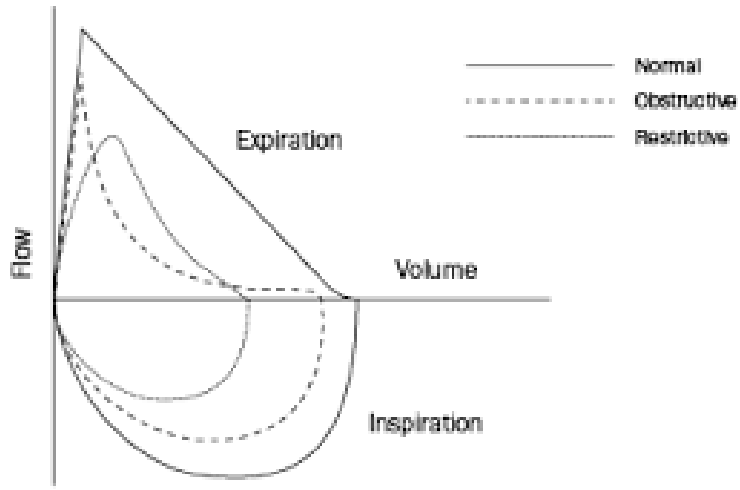
- Refer to Flow Volume Loop / FVC
  - Definition:
    - the maximal amount of air that can be exhaled forcibly and completely after maximal inspiration
  - > 80% = normal range
- FEF (Forced Expiratory Flow)
  - **flow** (or speed) of air coming out of the lung during the middle portion of a **forced** expiration

FEV1

- FEV_1
  - forced expiratory volume in the first second of the FVC maneuver
  - Measure of air flow in the first second, large airways (straw of the milkshake)
  - Use it with FVC
  - Determines the severity of obstruction

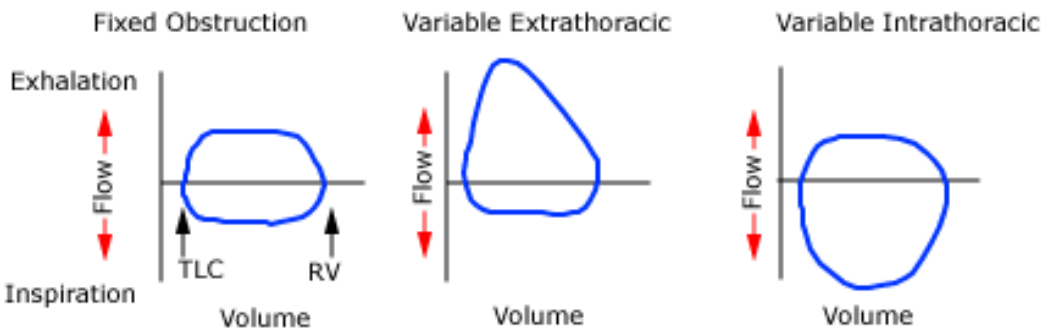
FEV1 / FVC (Ratio)

- FEV_1/FVC (ratio) shows how much air a patient can blow out in one second compared to how much air they can blow out, total.
- < 70% = Obstruction
- > 70% = NO obstruction / possible restriction
- Used with GOLD criteria for COPD staging


Normal
Obstructive
Restrictive
Expiration
Flow
Volume
Inspiration

Intrathoracic vs. Extrathoracic

- Measurement of smaller airways
  - FEF 25-75%
- Intrathoracic obstruction seen on exhalation
- Extrathoracic obstruction seen on inhalation

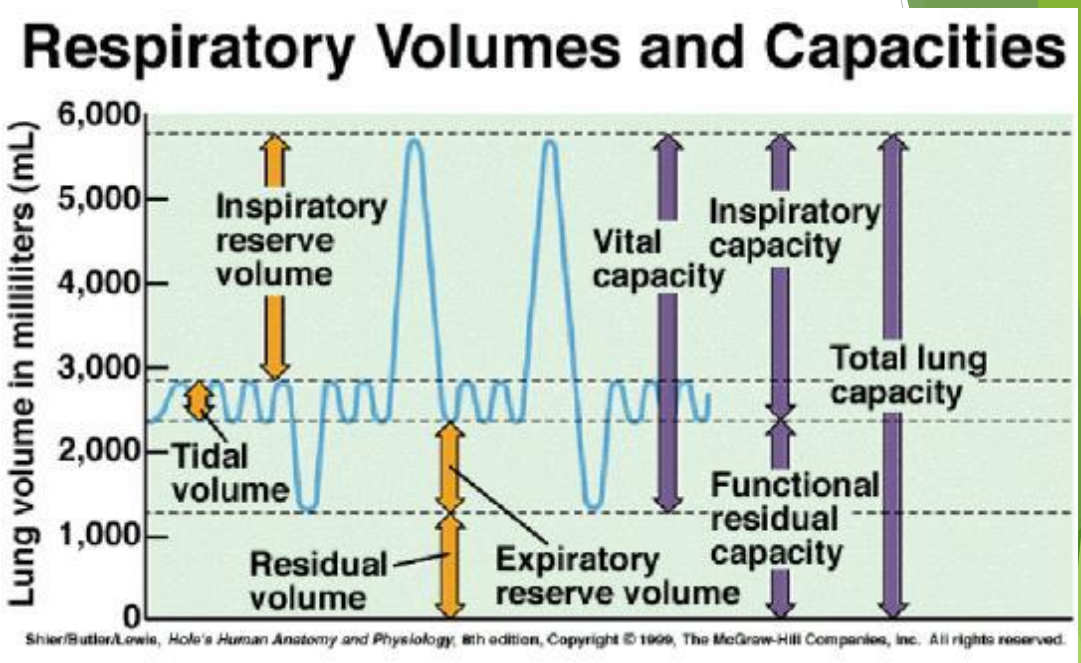

Fixed Obstruction
Variable Extrathoracic
Variable Intrathoracic
Exhalation
Flow
Inspiration
TLC
RV
Volume
Flow
Volume
Flow
Volume

Types of Obstruction

- Variable extrathoracic
  - VC paralysis, VC constriction
  - laryngeal edema
  - OSA with upper airway narrowing
- Variable intrathoracic
  - Tracheomalacia
  - Airway tumor
- Fixed Airway
  - Tracheal stenosis / post intubation
  - Goiter
  - Endotracheal mass

Lung Volumes and Capacities

- Measures air compartments of the lung
  - Air trapping or reduction in volume
  - Helps to differentiate between restrictive and obstructive


Respiratory Volumes and Capacities
Lung volume in milliliters (mL)
6,000
5,000
4,000
3,000
2,000
1,000
0
Inspiratory reserve volume
Tidal volume
Residual volume
Expiratory reserve volume
Vital capacity
Inspiratory capacity
Total lung capacity
Functional residual capacity
Shier/Butler/Lewis, Hole's Human Anatomy and Physiology, 8th edition, Copyright © 1999, The McGraw-Hill Companies, Inc. All rights reserved.

Lung Volumes and Capacities

- Tidal Volume
  - Volume of air inhaled or exhaled with each breath
- Expiratory Reserve Volume
  - Maximal amount of air forcefully exhaled after normal inspiration and expiration
- Inspiratory Reserve Volume
  - Maximal amount of air forcefully inhaled after normal inhalation

Lung Volumes and Capacities

- RV -Residual Volume
  - Amount of air left in the lungs after maximal exhalation
- VC -Vital Capacity
  - Maximum amount of air that can be exhaled after maximal inhalation
- TLC -Total Lung Capacity
  - VC+RV

RV Residual Volume

- Elevated value is consistent with air trapping, permanent in emphysema, reversible with bronchodilator in asthma
- RV can decrease in diseases that occlude alveoli
- Low RV is consistent with restriction
- RV increases with age

VC Vital Capacity

- Factors which influence VC:
  - Male vs. Female
  - Age
  - Respiratory muscle strength
  - Posture
  - Pregnancy

VC Vital Capacity

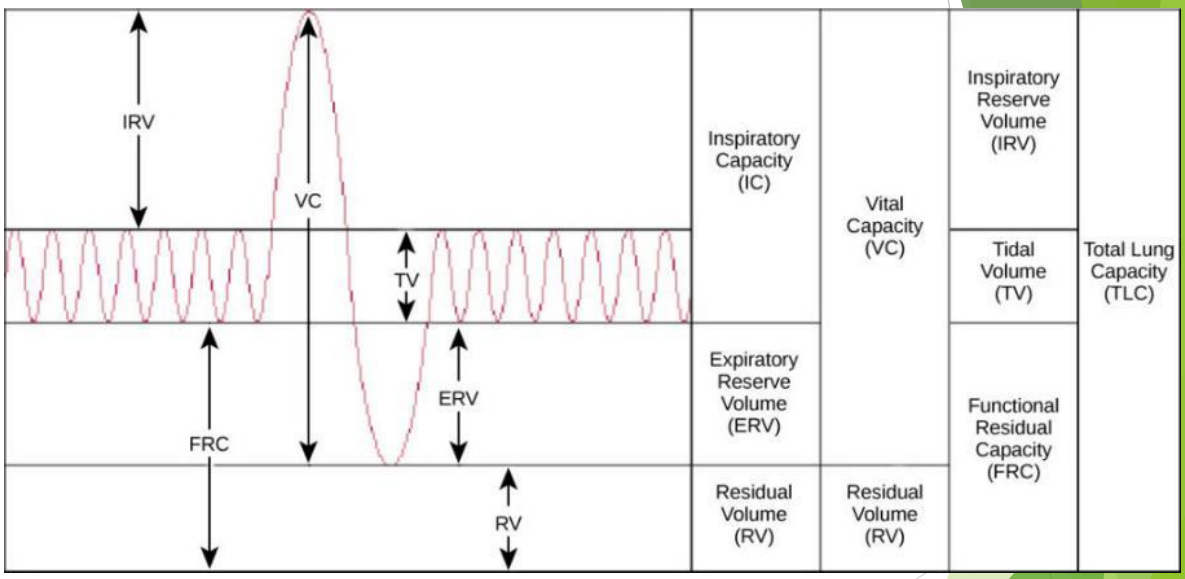
- Decrease can happen in restriction or obstruction
  - Depression of respiratory center in brain
  - Neuromuscular disease
  - Pleural effusion
  - Pneumothorax
  - Pregnancy
  - Ascites
  - Scleroderma
  - Kyphoscoliosis
  - tumors

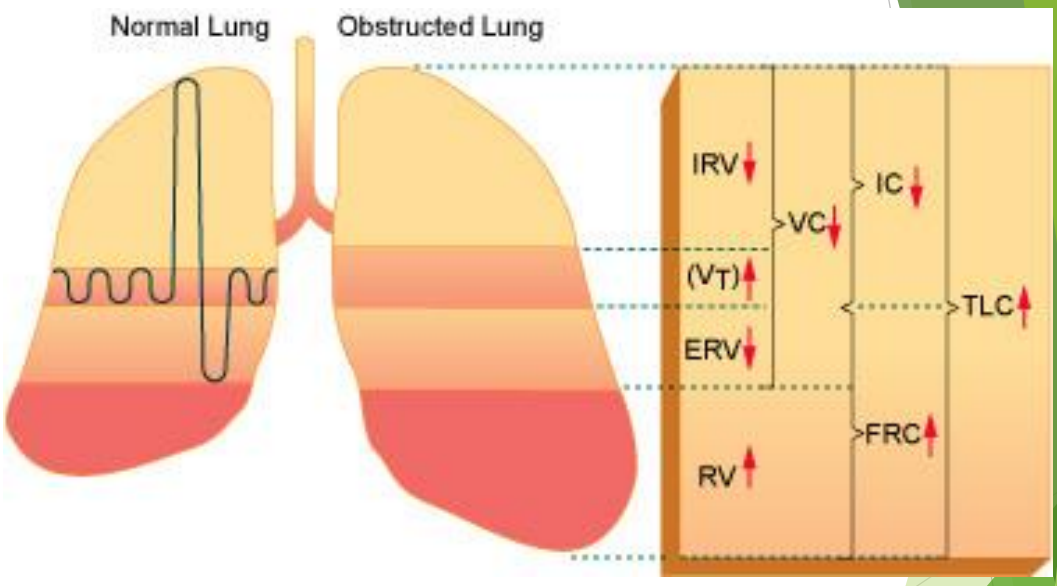
TLC Total Lung Capacity

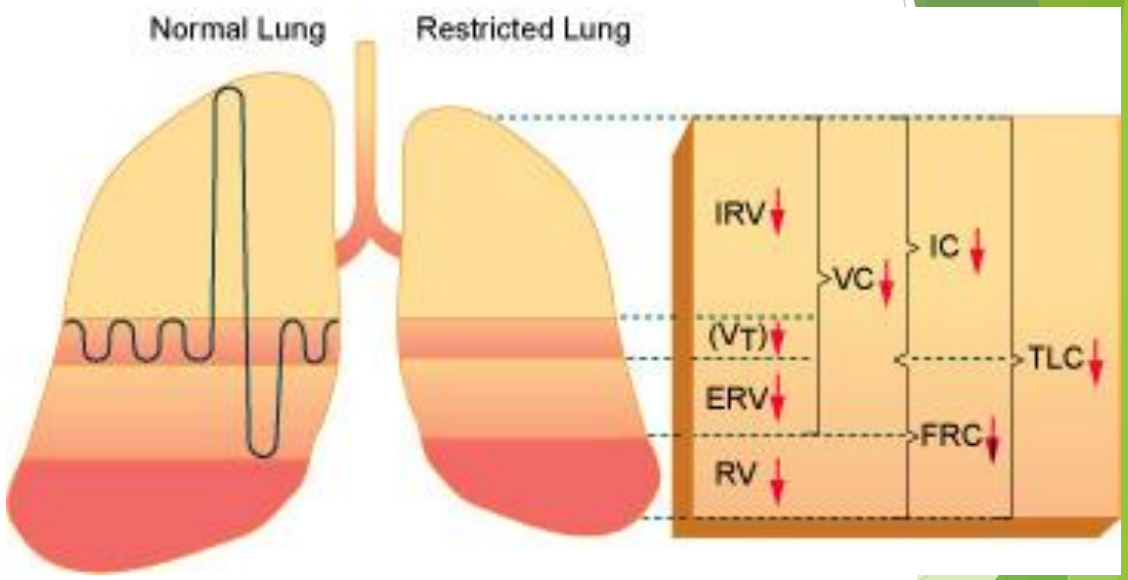
- Increased in obstruction, but can be normal or increased with hyperinflation/emphysema
- Decreased (IMPORTANT in RESTRICTIVE VENTILATORY DEFECT)
  - Edema
  - Atelectasis
  - Neoplasm
  - Pneumothorax
  - Thoracic restriction

Lung Volumes

- Minute Volume (MV)
  - Volume of gas inhaled or exhaled from a person's lungs per minute
  - TV x RR = MV
- FRC (Functional Residual Capacity)
  - Volume in lungs at the end of passive expiration
- ERV (Expiratory Reserve Volume)
  - The additional amount of air that can be exhaled from the lungs after normal TV
- IRV (Inspiratory Reserve Volume)
  - The additional amount of air that can be inhaled after normal TV

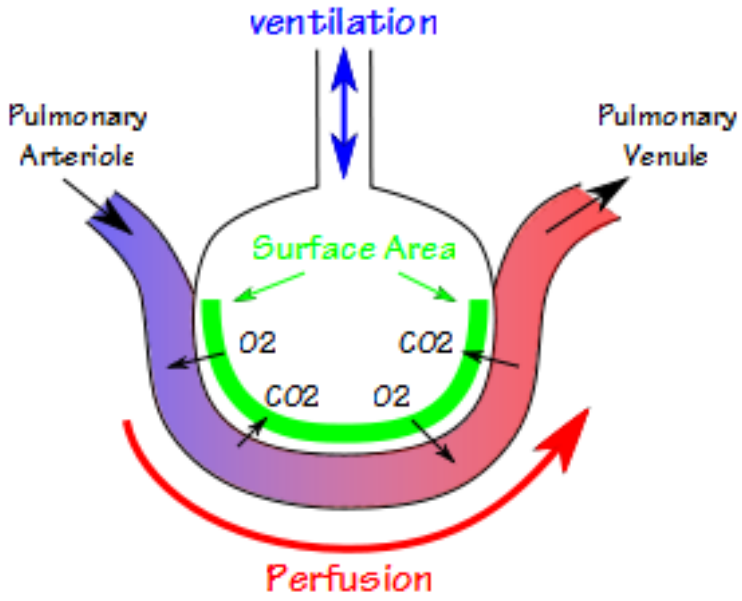

IRV
VC
TV
ERV
FRC
RV
Inspiratory Capacity (IC)
Expiratory Reserve Volume (ERV)
Residual Volume (RV)
Vital Capacity (VC)
Residual Volume (RV)
Inspiratory Reserve Volume (IRV)
Tidal Volume (TV)
Functional Residual Capacity (FRC)
Total Lung Capacity (TLC)


Normal Lung
Obstructed Lung
IRV
VC
IC
(VT)
TLC
ERV
FRC
RV


Normal Lung
Restricted Lung
IRV
VC
IC
(VT)
TLC
ERV
FRC
RV

Diffusing Capacity

- DLCO (how is it measured)
  - carbon monoxide diffused into lung (small amount)
  - Measures amount of CO binding to RBC
  - Take in DEEP breath, hold for 10 sec then exhale
  - Measures the surface area of the lungs
    - Total cross section of lungs = size of tennis court
  - Helps to differentiate diagnosis of restrictive lung disease
- DLCO / VA
  - Adjusted for alveolar ventilation
  - If DLCO is abnormal then calculate DLCO / VA
    - DLCO / VA > 80% extrinsic etiology
    - DLCO / VA < 80% intrinsic etiology
- > 80% normal surface membrane area


ventilation
Pulmonary Arteriole
Pulmonary Venule
Surface Area
O2
CO2
CO2
O2
Perfusion

DLCO

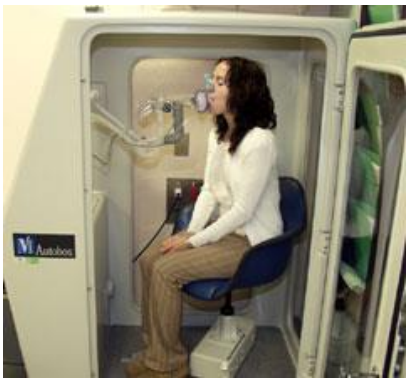
- Increased:
  - Polycythemia
  - Left to right shunts
  - Pulmonary hemorrhage / blood in alveoli
  - Exercise
- Usually normal in chronic bronchitis

- Decreased:
  - Architectural destruction of the lungs
  - Lack of taking in DEEP breath
    - Scoliosis, obesity, effort (extrinsic constriction)
  - methotrexate, PHTN, emphysema, fibrosis, scleroderma
  - Pulmonary emboli, anemia
  - Lung resection

COPD vs. Asthma with PFTs

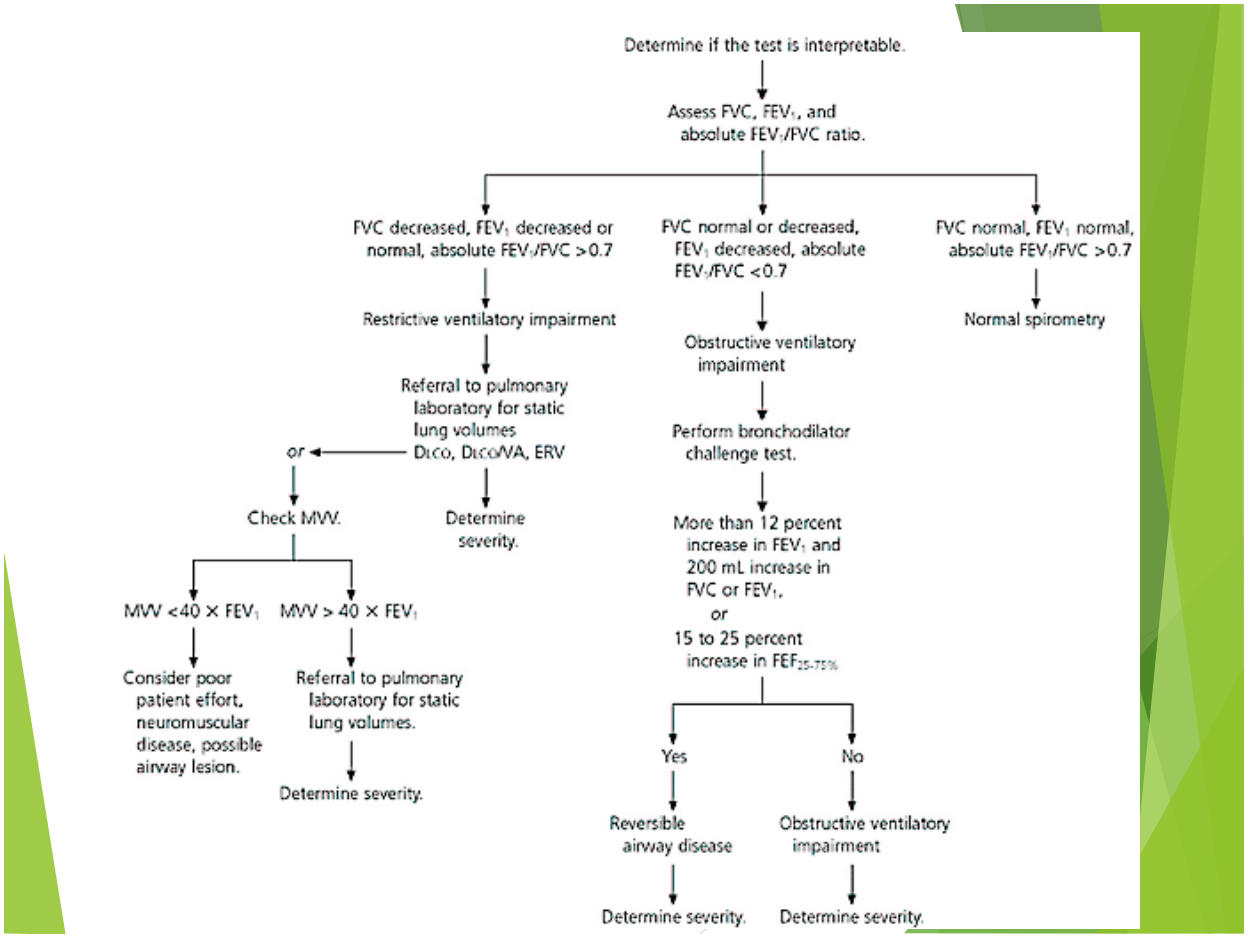
- COPD / Emphysema:
  - Ratio (FEV1 / FVC) < 70%
    - Decrease in DLCO
- Asthma
  - Ratio (FEV1 / FVC) < 70%
    - Intrathoracic pressure negative, more blood into heart -> into lungs which will increase # RBC in circulation, bind with CO
    - Increase or Normal DLCO

PFT Procedure



PFTs – Interfering Factors

- Recent bronchodilator use
- Respiratory infections
- Patient effort/inability to maintain airtight seal
- Exercise (increased cardiac output) and polycythemia interfere with DLCO
- Increased levels of COHb in smokers and anemia decrease the DLCO, but you can correct for this


Determine if the test is interpretable.
Assess FVC, FEV1, and absolute FEV1/FVC ratio.
FVC decreased, FEV1 decreased or normal, absolute FEV1/FVC >0.7
FVC normal or decreased, FEV1 decreased, absolute FEV1/FVC <0.7
FVC normal, FEV1 normal, absolute FEV1/FVC >0.7
Restrictive ventilatory impairment
Obstructive ventilatory impairment
Normal spirometry
Referral to pulmonary laboratory for static lung volumes DLCO, DLCO/VA, ERV
or
Perform bronchodilator challenge test.
Check MVV.
Determine severity.
More than 12 percent increase in FEV1 and 200 mL increase in FVC or FEV1, or 15 to 25 percent increase in FEF25-75%
MVV <40 × FEV1
MVV > 40 × FEV1
Yes
No
Consider poor patient effort, neuromuscular disease, possible airway lesion.
Referral to pulmonary laboratory for static lung volumes.
Reversible airway disease
Obstructive ventilatory impairment
Determine severity.
Determine severity.
Determine severity.

Interpreting PFTs

- Step 1: FVC
  - > 80% = NO RESTRICTION
  - < 80%
    - Restriction OR Obstruction with air-trapping
    - TLC > 80% = Obstruction with air-trapping
    - TLC < 80% = Restriction
- Step 2: Ratio (FEV1 / FVC)
  - > 70% = NO OBSTRUCTION
  - < 70% = OBSTRUCTION

Severity of Obstruction

- GOLD Grades (FEV1)
  - 1: 80-100%
  - 2: 50-80%
  - 3: 30-50%
  - 4: 0-30% or respiratory failure with elevated pCO2
- Reactivity //Bronchodilator response is defined as +200cc, AND 12% by ATS (Amer. Thoracic Society) guidelines

GOLD Guidelines 2019

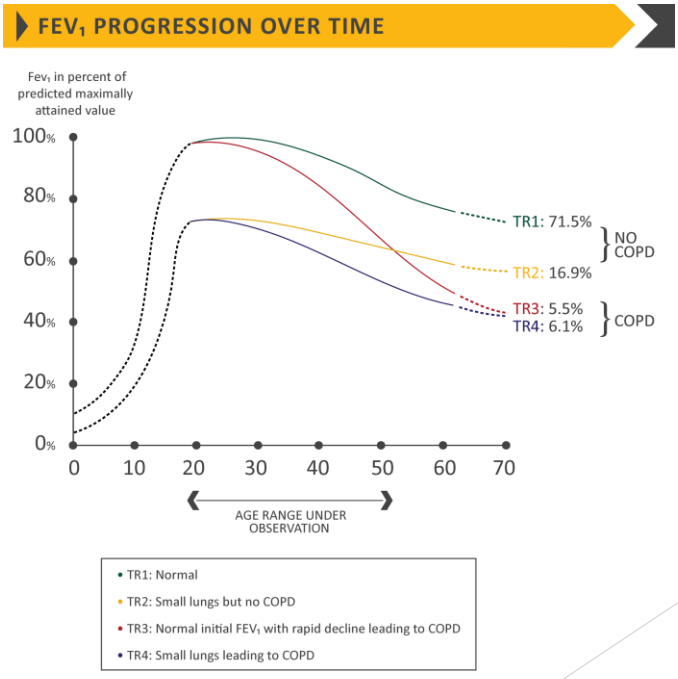
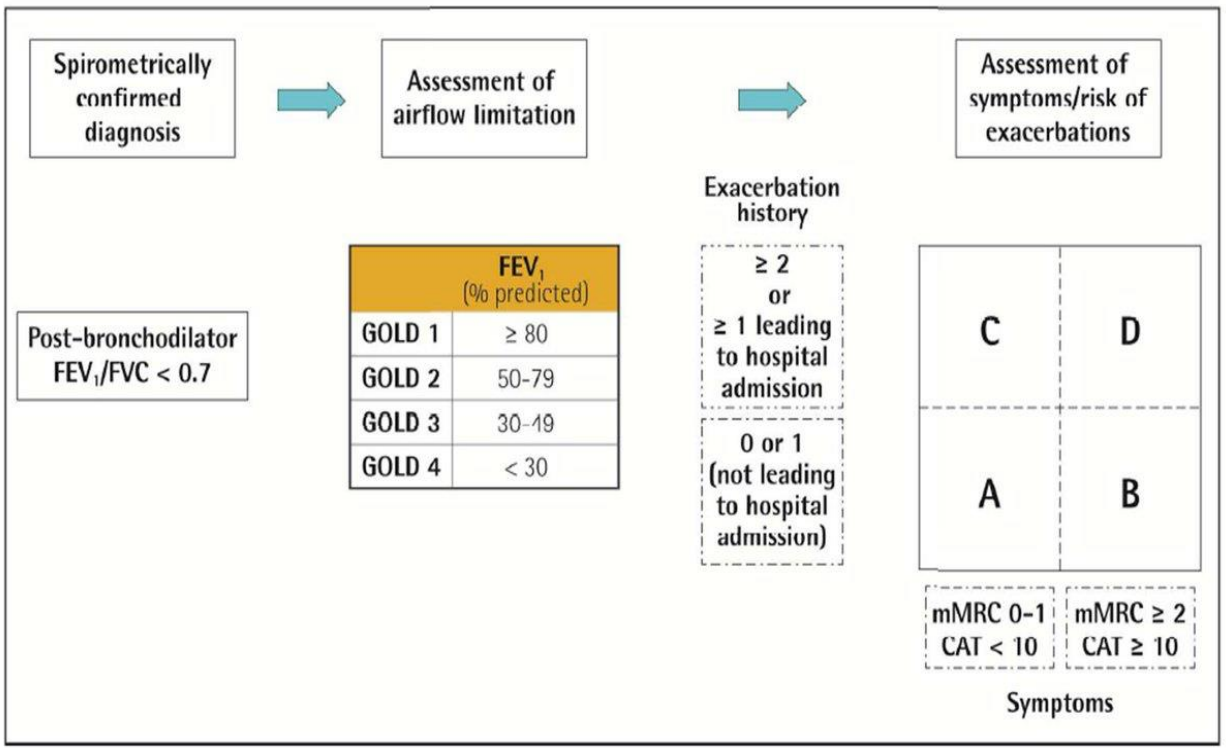
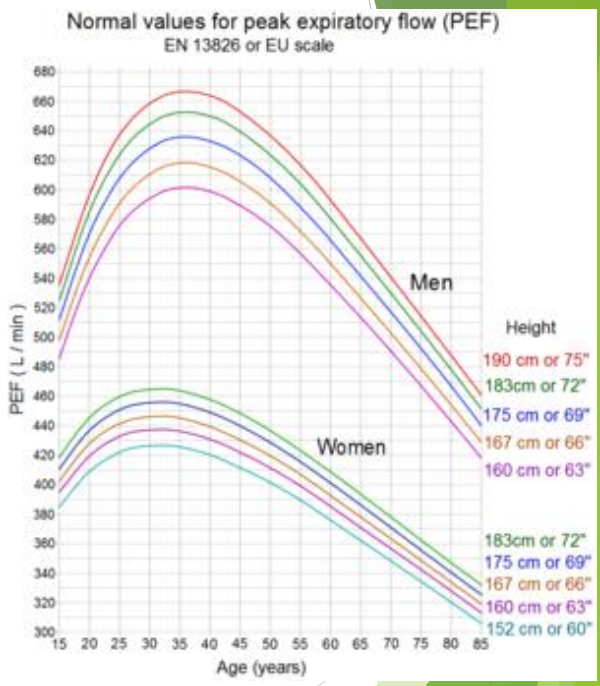


FIGURE 1.2


Spirometrically confirmed diagnosis
Assessment of airflow limitation
Assessment of symptoms/risk of exacerbations
Post-bronchodilator FEV1/FVC < 0.7
FEV1 (% predicted)
GOLD 1 ≥ 80
GOLD 2 50-79
GOLD 3 30-49
GOLD 4 < 30
Exacerbation history
≥ 2 or ≥ 1 leading to hospital admission
0 or 1 (not leading to hospital admission)
C
D
A
B
mMRC 0-1 CAT < 10
mMRC ≥ 2 CAT ≥ 10
Symptoms

PEFR

- Peak Expiratory Flow Rate
  - Highest forced exp. Flow measured with a peak flow meter



Methacholine Challenge Test

- Bronchial provocation is done in patients with normal pulmonary function suspected of having some hyperreactivity
- Positive test is >20% decrease in FEV_1 from baseline
- 5-10% of asthmatic patients do not respond to methacholine

MCT - Procedure

- FEV_1 at baseline
- Patient then inhales increasing concentrations of methacholine; with each dose, measure FEV_1
- Give an inhaled bronchodilator if a 20% response is shown
- There are usually 6 measurements taken, and if a 20% decrease is not achieved, the test is considered negative
- Be sure your lab follows ATS guidelines for methacholine dosing
- Histamine test is the next step if you are still suspicious

Case Studies

Case Study 1

- 44 yo with pmhx of childhood asthma, CAD s/p CABG and HTN presented to ER with HA and was found to have HTN urgency. He was admitted, started on anti-hypertensive agents and his BP improved.
- Subsequently he developed intermitted stridor and spirometry was obtained
- INTERPRET

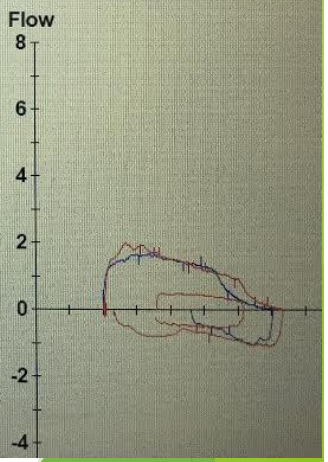
ATLANTA

PULMONARY FUNCTION REPORT

Dyspnea Rest: No Dyspnea Exercise: Yes
Cough: No Persistent: No Productive (cc):
Smoker: No Cigarettes: No Cigars: No Pipe: No
How Long: Quit: No Stopped:

Date of Test: 02/17/17
Birth Date: 12/28/72 Age: 44
MRN: 903852778
Height(in): 69.0 Weight(lb): 275 BMI:
Gender: Male Race: African-Amer
Diagnosis: SHORTNESS OF BREATH
Room: 415
Provider: JERMAINE JACKSON MD
Technician: SYJ

Spirometry		Ref	Pre	% Ref	Post	% Ref	%Chg
FVC	Liters	4.14	2.52	61	2.67	64	6
FEV1	Liters	3.37	1.52	45	1.61	48	6
FEV1/FVC	%	81	60	74	60	74	0
FEV6	Liters	4.05	2.46	61	2.63	65	7
FEF25-75%	L/sec	3.49	1.20	34	1.25	36	4
FEF50%	L/sec		1.38		1.34		-3
PEF	L/sec	8.80	1.67	19	1.99	23	19
FET100%	Sec		11.90		16.74		41
FIVC	Liters		1.20		2.51		109
FIF50%	L/sec		0.67		0.63		-6
FVL Time			12:27		12:44		



Case Study 1 Answer

- Showed Fixed airway obstruction
  - Differential diagnosis
  - What in his PMHx might cause this?
  - Treatment required was tracheostomy to protect the airway

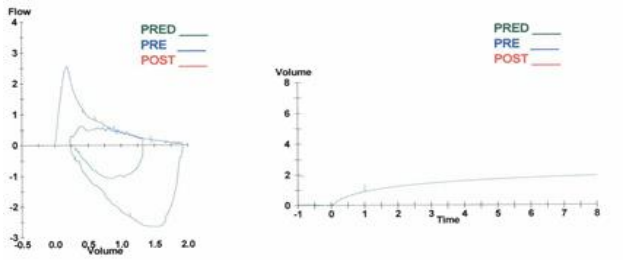
Case Study 2

- 54 y/o female with PMH significant for HFpEF, CAD, HTN, obesity, and chronic respiratory failure with PFTs below. She has a 40 py history of smoking and unfortunately continues to smoke ½ ppd despite measures to quit with Chantix, Wellbutrin, and nicotine replacement therapy. She complains of daily significant dyspnea on exertion, wheeze and chronic cough, mostly productive when she first wakes up in the morning of white sputum. She has tried albuterol HFA in the past with only minimal relief of these symptoms.

Case Study 2

---Spirometry---

		Ref	Pre Meas	Pre % Ref	Post Meas	Post % Ref	Post % Chg
FVC	Liters	3.21	1.93	60			
FEV1	Liters	2.53	0.92	36			
FEV1/FVC	%	80	48				
FEF25%	L/sec		1.01				
FEF75%	L/sec		0.17				
FEF25-75%	L/sec	2.52	0.36	14			
PEF	L/sec	6.29	2.58	41			
FIVC	Liters		1.69				
PIF	L/sec		2.65				



Case Study 2 Answer

- Patient's spirometry reveals severe obstruction. Her flow volume loop shows concavity, which is consistent with obstruction. In patients with COPD that is severe with significant symptoms.
- Consider LAMA/LABA as treatment
- If there is frequent exacerbations, such as with this patient consider adding ICS as it has been proven to reduce exacerbations. Caution recurrent pneumonia, which is an increased risk while using ICS.

Case Study 3

- 57 y/o female with PMH significant for hepatopulmonary syndrome as well as OSA, chronic respiratory failure and obesity complains of dyspnea no exertion. She denies any wheeze, chronic cough. She does note intermittent LE swelling that seems to be controlled well with furosemide 20 mg daily. She is a current smoker, smoking < ½ ppd with smoking history of 12 years. Recent echo performed shows mild to moderate pulmonary HTN with RVSP of 45 mm Hg. Recent Hi-Res CT chest shows centrilobular emphysema (upper lobe predominant) without any fibrosis, honeycombing, bronchiectasis, or reticulations.

Case Study 3

--- SPIROMETRY ---	Pre - Bronchodilator Pred	Actual	%Pred	LLN	Po Ac
FVC (L)	3.55	3.25	91	2.84	
FEV1 (L)	2.78	2.50	90	2.18	
FEV1/FVC (%)	79	77		69	
FEF 50% (L/sec)		3.02			
FEF 75% (L/sec)		0.71			
FEF 25-75% (L/sec)	2.62	2.12	81	1.34	
FEF Max (L/sec)	6.69	8.66	129	4.93	
FIVC (L)		2.79			
FIF Max (L/sec)		5.37			

--- LUNG VOLUMES ---	Pred	Actual	%Pred	LLN - ULN
SVC (L)	3.55	3.25	91	2.84
IC (L)	2.19	1.68	77	1.75
ERV (L)	1.10	1.44	131	0.87
TGV (L)	2.93	3.09	105	1.86
RV (Pleth) (L)	1.94	1.52	79	1.16 - 2.71
TLC (Pleth) (L)	5.20	4.77	92	4.12 - 6.28
RV/TLC (Pleth) (L)	37	32		26 - 48
Trapped Gas (L)				

--- DIFFUSION ---	Pred	Actual	%Pred	LLN
DLCOunc (ml/min/mmHg)	25.9	15.4	59	19.9
DLCOcor (ml/min/mmHg)	25.9	15.4	59	19.9
DL/VA (ml/min/mmHg/L)	5.21	3.51	68	3.90
VA (L)	5.20	4.38	84	4.12

-Airways Resistance-	Pred	Actual	%Pred	LLN
Raw (cmH2O/L/s)	1.98	1.27	64	
Gaw (L/s/cmH2O)	0.482	0.785	163	
sRaw (cmH2O*s)	3.99	4.88	123	
sGaw (L/cmH2O*s)	0.251	0.205	82	

---Max Pressures---	Pred	Actual	%Pred
MEP (cmH2O)	141		
MIP (cmH2O)	76		

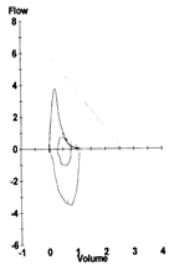
Case Study 3 Answer

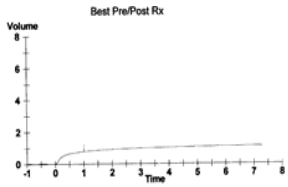
- This patient's PFT do no demonstrate any obstructive nor restrictive defects given FEV1/FVC ration >0.70, TLC is 92%. She does have moderately reduced DLCO that does not correct for alveolar volume (68%). This can likely be attributed to her pulmonary HTN +/- emphysema. When a patient complains of SOB with reduced diffusion capacity with otherwise normal PFTs considerations include, but are not limited to pulmonary HTN, acute PE, emphysema.
- Other considerations may include heart failure, valvular heart diseases. Any disease that affects the pulmonary parenchyma or circulation can affect diffusion capacity. It is a measure of the integrity of the alveolar-capillary membrane, essentially how well the lungs are exchanging CO for O2.

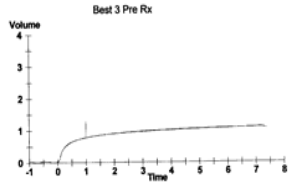
Case 4

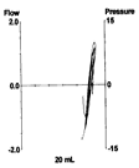
- 56 y/o female with PMH significant for Scleroderma (Systemic Sclerosis) and Rheumatoid Arthritis who complains of moderate dyspnea on exertion. She is currently managed on mycophenolate and daily prednisone per her rheumatologist for her autoimmune/connective tissue diseases. She also admits to intermittent cough as well as mild intermittent lower extremity edema. On CXR in clinic she is noted to have increased interstitial markings with suggestion of enlarged pulmonary artery.

Case 4









Best 3 Post Rx

Test Comments:

— SPIROMETRY —	Pre - Bronchodilator Pred	Actual	%Pred	LLN	Post - Bronchodilator Actual	%Pred	Change
FVC (L)	2.57	1.10	43	1.90			
FEV1 (L)	2.04	0.78	38	1.47			
FEV1/FVC (%)	81	71	88	70			
FEF 50% (L/sec)		0.89					
FEF 75% (L/sec)		0.13					
FEF 25-75% (L/sec)	2.48	0.48	19	1.32			
FEF Max (L/sec)	5.62	4.13	73	3.75			
FIVC (L)		1.04					
FIF Max (L/sec)		3.51					

— LUNG VOLUMES —	Pred	Actual	%Pred	LLN - ULN
SVC (L)	2.57	1.10	43	1.90
IC (L)	1.95	0.66	34	1.50
ERV (L)	0.97	0.35	36	0.75
TGV (L)	2.64	1.27	48	1.57
RV (Pleth) (L)	1.76	0.93	53	0.98 - 2.53
TLC (Pleth) (L)	4.73	2.02	43	3.65 - 5.80
RV/TLC (Pleth) (L)	37	46	124	26 - 48
Trapped Gas (L)				

— DIFFUSION —	Pred	Actual	%Pred	LLN
DLCOunc (ml/min/mmHg)	24.0	7.8	32	18.0
DLCOcor (ml/min/mmHg)	24.0	7.8	32	18.0
DL/VA (ml/min/mmHg/L)	5.23	3.68	70	3.92
VA (L)	4.73	2.12	45	3.65

-Airways Resistance-	Pred	Actual	%Pred	LLN
Raw (cm/H2O/L/s)	1.53	3.18	207	
Gaw (L/s/cmH2O)	0.605	0.315	52	
sRaw (cmH2O*s)	3.86	5.53	143	
sGaw (L/cmH2O*s)	0.259	0.181	70	

—Max Pressures—	Pred	Actual	%Pred
MEP (cmH2O)	141		
MIP (cmH2O)	76		

Case 4 Answer

- This patient has severe restriction with a moderately reduced diffusion capacity that does not correct for alveolar volume. She does not have any obstruction as her FEV/FVC ratio is >0.70 and therefore bronchodilator was not administered during her complete PFTs. Given her history of connective tissue/autoimmune disorders further imaging is warranted in this patient. HRCT (high resolution CT scan) of the chest should be performed to look for interstitial lung disease. It may also be prudent to obtain an echo to look for pulmonary hypertension given history of swelling and suggestion of enlarged pulmonary artery on prior imaging.

- HRCT showed this patient had changes consistent with interstitial lung disease, likely related to her autoimmune/connective tissue diseases. She is currently treated for those diseases per rheumatology with mycophenolate, prednisone, which in turn is the treatment for her ILD. Her echo showed elevated RVSP at 60 mm Hg (suggestive of pulmonary HTN) as well as RV dilation and mildly reduced systolic function. Pulmonary Hypertension can cause reduced DLCO as can ILD.

Case 5

- 47 y/o obese (BMI 45 kg/m^2) female who presents to clinic complaining of moderate to severe dyspnea with exertion, worsened during the summer months when the weather is hot and hazy. She admits to history of childhood asthma however notes “It seemed to go away for a long time”. She is a lifelong non-smoker. Patient has had three ED visits in the past several months with complaints of chest tightness, wheeze, and shortness of breath. She denies significant cough, chest congestion, hemoptysis, LE swelling. Cardiac history is unremarkable.

Case 5

Test Comments:

--- SPIROMETRY ---	Pre - Bronchodilator Pred	Actual	%Pred	LLN	Post - Bronchodilator Actual	%Pred	Change
FVC (L)	3.48	1.61	46	2.67	2.02	58	25
FEV1 (L)	2.81	1.01	36	2.11	1.35	48	33
FEV1/FVC (%)	82	63		71	67		
FEF 50% (L/sec)		0.70			1.04		49
FEF 75% (L/sec)		0.21			0.28		32
FEF 25-75% (L/sec)	3.14	0.52	16	1.73	0.76	24	46
FEF Max (L/sec)	7.09	2.56	36	4.80	4.03	57	57
FIVC (L)		1.33			1.69		27
FIF Max (L/sec)		1.44			2.53		76

--- LUNG VOLUMES ---	Pred	Actual	%Pred	LLN - ULN
SVC (L)	3.48	1.64	47	2.67
IC (L)	2.60	1.19	46	2.15
ERV (L)	1.30	0.30	23	1.08
TGV (L)	3.23	1.98	61	2.16
RV (Pleth) (L)	1.95	1.53	78	1.18 - 2.73
TLC (Pleth) (L)	5.73	3.17	55	4.65 - 6.81
RV/TLC (Pleth) (L)	34	48		23 - 45
Trapped Gas (L)				

--- DIFFUSION ---	Pred	Actual	%Pred	LLN
DLCOunc (ml/min/mmHg)	29.4	15.1	51	23.4
DLCOcor (ml/min/mmHg)	29.4	15.1	51	23.4
DL/VA (ml/min/mmHg/L)	5.41	6.23	115	4.10
VA (L)	5.73	2.42	42	4.65

-Airways Resistance-	Pred	Actual	%Pred	LLN
Raw (cm/H2O/L/s)	1.78	5.20	293	
Gaw (L/s/cmH2O)	0.530	0.192	36	
sRaw (cmH2O*s)	3.93	13.72	349	
sGaw (L/cmH2O*s)	0.254	0.073	29	

---Max Pressures---	Pred	Actual	%Pred
MEP (cmH2O)	145		
MIP (cmH2O)	80		

Case 5 Answer

- This patient has an obstructive defect. Her FEV1/FVC ratio is <0.70 with FEV1 36%, therefore the obstruction is severe. Her obstructive shows positive bronchodilator response (or reversibility) of 33%, which is significant (12% or 200 mL change in FEV1 after administration in bronchodilator is considered reversible). There is also some restriction noted however her diffusion capacity is not affected as it is 115% therefore it is suspected to be reduced given her body habitus. Her PFTs are consistent with asthma, likely severe, persistent.
- It would be recommended to obtain CBC with diff for EOS count, IgE and an allergen panel in this patient to determine if she is a candidate for biologic therapies in addition to the high dose ICA/LABA and SABA she is currently using.

Clinical Citations

- 2020 GOLD Global Initiative for Chronic Obstructive Lung Disease
- Pulmonary Function Tests - PFT Interpretation Explained (Pulmonology); Roger Seheult, MD